The Ulster Medical Journal, Volume 59, No. 2, pp. 110–118, October 1990.

The self and its brain

R J McClelland

Accepted 19 April 1990.

Based on a Lecture delivered to a joint meeting of the Ulster Medical Society and the Ulster Neuropsychiatric Society on 16th March 1989.

In 1973 Philippe Pinel, physician in charge of the Bicetre asylum in Paris, literally removed the chains from his patients and ordered that they should be treated with kindness and understanding.[1] This action reflected two important phenomena. One was the spirit of humanitarianism abroad in France at the time. The other was an emerging view of mental illness as a natural or biological phenomenon. Those afflicted were sick, they were mentally ill.

Prior to this time the contents of the human mind — thoughts, feelings, motivation — were very much the concern of the Church. Because the mind was conceived as a free agent, free from bodily and physical constraints, human beings were considered responsible for any abnormality in their behaviour or beliefs. Those with a disorder of thought or perception were usually believed to be in consort with the devil. It is perhaps paradoxical that the scientific reductionism dawning in the 18th century was associated with a new and liberating doctrine which sought to restore human dignity to the mentally ill. Taking a wider view — from the Greek scientist-philosophers through to the modern psychobiologists — the issue that has most profoundly exercised the minds of men is the relation between the mind, of which each of us is personally aware, and the body. Is there a relationship, and if so what is its nature? The search for an explanation has come to be known as the mind-body problem, described by the philosopher Schopenhauer as the world knot.[2] But the mind-body issue should not be the remote province of philosophers; the brain and the mind are as weft and warp in the fabric of psychiatry — in the evaluation, diagnosis, and care of the mentally ill. The physician or general practitioner who takes account of this psycho-soma relationship enlarges his understanding of his patients and their illnesses.

I. *Defining the problems*

One of the biggest problems is that we have a certain commonsense picture of ourselves as conscious, free, rational agents; my existence as a self is a reality beyond any possibility of doubt (Fig 1). This view, however, is very hard to square with our overall scientific concept of the physical world: a world that science tells us consists of mindless, physical particles. How can it be that the world contains nothing but inanimate particles and yet that it also contains self-consciousness?

Department of Mental Health, The Queen's University of Belfast, Whitla Medical Building, 97 Lisburn Road, Belfast BT9 7BA.

R J McClelland, MD, PhD, FRCPsych, Professor of Mental Health.

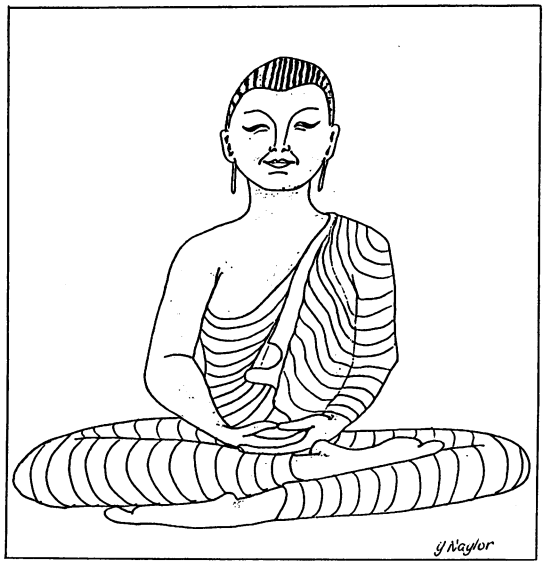

Fig 1. Buddha, who found enlightenment through prolonged contemplation under the Bodhi tree — symbolising *res cogitans* (thinking substance).

Fig 2. René Descartes (1596–1650).

Before proceeding further with our analysis of the issue I would like to trace the contribution of science to the world knot. This has its origins in the 17th century with the philosopher René Descartes, regarded by many as the father of modern science (Fig 2). Descartes asserted that the body was a machine, and this had a profound effect on medical science. First, it had a liberating effect on biology, allowing scientists to investigate animals as if they were machines.[3] Second, it taught that the human body was not sacred, but could be dissected and studied in the same way as any other physical system could be, except in so far as the rational mind was concerned. However, Descartes also accepted the traditional view that the rational mind, soul, or self was immaterial and immortal and hence accessible only to philosophy and theology, but not to science. Herein we see the origin of an important obstacle to the scientific study of mind; but an even greater problem was to follow.

The mind, within this framework was not a natural phenomenon. It stood outside nature. The effect of this conceptualisation was to leave this self, the inner person, perched precariously on the edge of matter and in strange conjunction with its body[4] (Fig 3). Soon the question was posed of how an immaterial non-natural mental thing, the mind, could act on a material body? With the subsequent rise in status of the physical sciences, the status of mental entities has been generally downgraded. A central thesis of modern scientific reductionism is that all physical substances, including the human body, can be reduced to simple particles and the forces acting on them. With this comes a determinism according to which the human mind is feeble and unfree. Thus most of the recent materialist conceptions of the mind — such as behaviourism and physicalism — have ended up by denying implicitly or explicitly that there is any such thing as a mind as we ordinarily think of it: ideas or feelings, for example, are at most mere epiphenomena and of no causal significance.[5] With these two contributions of

science to our problem we have inherited a cultural resistance to treating the conscious mind as a biological phenomenon.

There are three features which seem impossible to fit into our scientific conception of the world as made up exclusively of physical things: consciousness, mental causation, and subjectivity. First is the notion of consciousness itself. It is hard to see how a physical system, the central nervous system, could have consciousness and yet you, the reader, at this moment are presumably conscious. Once again Descartes was the first of the modern philosopher-scientists to address the problem. In his *Méditations* of 1630 he introduced the method of doubt as a technique for identifying the essence or true nature of things. Regarding the reality of the self, he speculated whether he might be the victim of a perceptual illusion, that perhaps his whole life was a dream. Then he noticed what seemed like a solid rock of truth — whatever doubts one may have about the truth of the content of one's thoughts there is never any reason to doubt one is having thoughts, that one is thinking. Any attempt to doubt or deny that one is thinking is quite nonsensical, since the very process of doubting or denying is itself thinking?

Fig 3. In the dualist philosophy of the mind and the brain, *res cogitans* (thinking substance) lies outside the body.

For Descartes this was the central truth regarding the reality of existence of the mind or the self — *cognito, ergo sum,* I think therefore I am. For the neurobiologist J Z Young, even more fundamental was the reality "I know that I am alive".[6] For the philosopher Sir Karl Popper the realisation of death is one of the great discoveries associated with full human self-consciousness — "to know that I will someday die is to recognise that I am alive, that I am, that I am a self".[7]

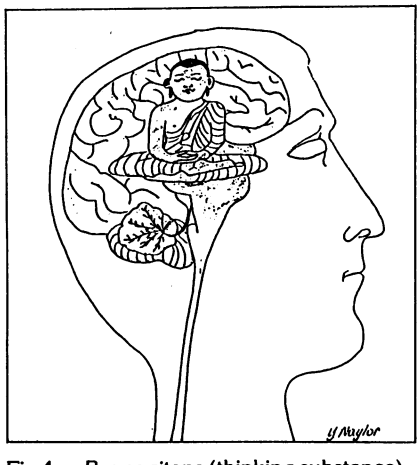

Fig 4. *Res cogitans* (thinking substance), or the self, often conceptualised as a person or homunculus within.

Consciousness is a dominating feature of existence, yet it is hard to characterise. The typical method of overcoming the difficulty is to speak of oneself as an inner entity, an inner thing, which leads to the postulation of an agent or person within. This was the origin of Descartes' homunculus[3] (Fig 4). The notion of a distinct and separate mind-thing and a body, or the dualist philosophy of the mind, is part of established tradition and therefore at the crux of my theme.

The second intractable feature is mental causation. We all assume that our thoughts and feelings significantly affect our action, that our mind does have a causal effect on the world around us. But if our thoughts and feelings are truly mental and immaterial, how can they affect anything physical? To take the illustration provided by the American philosopher John Searle, "are my thoughts not just as the froth on the wave is to the movement of the wave?" If the froth were conscious, it might think to itself "what a tough job it is pulling these waves up on the beach and then pulling them out again all day long!" but we know that the froth does not make any important difference. Why do we then suppose that our mental life is any more important than froth on the wave of physical or scientific reality?[5] Are we supposed to think that our thoughts and feelings can somehow produce effects on our brains and on the rest of our nervous system? How could such a thing occur? And yet unless there is some kind of connection between the mind and the brain it would seem that the mind cannot have any causal influence on the physical world.

A third important feature of the mind is subjectivity — for example I see the world from my point of view, you see it from yours. It is a characteristic feature of the present era that we have come to think of scientific reality as something that is objective — which is accessible to all observers. How can we reconcile the reality of subjective mental phenomena with this objective perspective of science?

Thus far we have defined the hard problems associated with three special properties of the mind: consciousness, mental causation, and subjectivity. The problems are that philosophy tends to split consciousness from body or brain, that scientific reductionism tends to deny mental causation, and that science resists the reality of the subjective.

TOWARDS A POSSIBLE SOLUTION

These features are what make the mind-body problem so difficult. Yet they are all very real features of our mental lives and any satisfactory account of the mind and of mind-body relations must take account of them.[5] On the one hand there are mental things such as our thoughts and feelings; we think of them as conscious, subjective, and immaterial. On the other hand there are physical things; we think of them as having mass and as interacting causally with other physical things. How can we account for the relationships between these two apparently completely different kinds of things? As J Z Young has commented, philosophers generally have paid little attention to the fact that knowledge and thought are somehow related to the brain.[6] Nevertheless it in imperative for neuroscience and medicine that we close this gap that keeps the study of mind a scientific anomaly. Fortunately over the last decade there has been an increasing interchange between philosophers and scientists.

I would like to examine briefly two modern responses to our problems. To begin with, the very expression "mind-body problem" suggests that mind and body are two separate entities. Yet we do not speak of the "motion-body problem" in mechanics or of the "lung-respiration problem" in physiology. Popper suggests one reason we have become confused about mind-body issues is that biology emphasises that organisms are hierarchies of structures rather than hierarchies of processes.[7] The philosopher John Searle reminds us that the mind should not be considered as a thing but rather as a process, a high level process of the brain. Such processes have parallels in other organ systems, for example in the way excretion is not a thing but a process or series of processes of the kidney embracing such specific functions as filtration and reabsorption.

Secondly the mind-brain identity theory, which has become the strongest thrust in materialist philosophy, has itself undergone substantial change. Initially it was strongly reductivist, holding that a complete account of mental processing is possible, in principle, in neural terms. The introduction in the mid-1960's of the opposing view of consciousness as an emergent process has been followed by transformations in the identity theory. Within this framework mental phenomena, while constrained by neural activity, also obey rules that are different in kind from those of their constituent neural material.[8] Mental laws are involved in determining behaviour and are necessary to explain behaviour.

It is important therefore to recognise that mind and brain are not identical: there is no more brain-mind identity than there is lung-respiration identity. To consider mind as a process, as an emergent function of brain, opens up several new possibilities. Note however, that such a mentalist position is not dualist but monist. Conscious processes are properties of the brain. Subjective events are generated and exist only by virtue of brain activity. They are inseparable from their physiological substructure. Yet once generated from neural events, higher order mental patterns have their own subjective qualities, operating and interacting by their own causal laws and principles. Compared to the physiological processes, conscious events are more molar.[8] The mental entities transcend the physiological, just as the physiological transcends the molecular. The meaning of experienced mental phenomena matters, and on the basis of such meaning we react. A catalogue of evidence from clinical psychiatry and behavioural neurology testifies to the importance of meaning as a causal factor in mental and behavioural adjustment and maladjustment.

Such psychoneural monism reduces to the following thesis: that all mental states and processes are processes in brains, and these states and processes are emergent relative to those of the cellular components of the brain.[9] The whole is more than the sum of its parts.

RESISTANCE

In considering our natural resistance to giving up the simple *dualistic* notion of a separate mind entity and brain entity, it is helpful to recount an earlier debate in the history of science. Biologists and philosophers have for a long time thought it was impossible to account for the existence of life itself on purely biological grounds. Some other additional element must be necessary. It is difficult today to realise how intense the dispute was between vitalism and mechanism even a generation ago. We now know there is no vital substance. Living things are physical systems made up of a small selection of the elements that make up the rest of earth. Moreover in nearly all respects the combination of these elements in living things behave like those in the organic world. Nearly, that is, but not entirely, and here we find two properties of all living things which give insight into our problem of conscious selves.

The first property is causality — all living things are in fact causal, they act in ways to ensure survival. They are not just the passive effects of lower forces. Their actions may be constrained to a large degree by molecular determinates, a reductionist account. However, living organisms also pursue aims, they act for some purpose so that teleological accounts are also valid.[6] Indeed if we accept Darwinian evolutionary theory then teleological accounts of biological activities, including mental activities, are just as valid as reductionist explanations.

Second and related is the notion of emergence. Popper proposes that there have been two major emergent phenomena in evolution — life itself and consciousness.[7] Life has arisen unexpectedly as an emergent property of the relationships of large amino acid structures. Consciousness is yet another highly improbable emergent event. It emerged in evolution in order to confer advantages for survival. Self-consciousness is a major upward step in our very long phylogenic history. A key conclusion from this analysis is that logic strongly suggests that all mental events are associated with changes in the brain. Intellectual activity and emotional experience all require activity in the brain and we are utterly dependant upon it.

Accepting the foregoing analysis one can talk about mental phenomena without leaving the biological ground.[9] Modern psychobiology seeks to explain the correlations that exist between neural activities and mental or behavioural events.

CODING, REPRESENTATION AND LANGUAGE

We now examine some of the contributions of modern neuroscience to our theme. One difficulty is the relative youth of neuroscience. For example Cajal's neuronal hypothesis of the brain is less than one hundred years old, but the last three or four decades have seen major conceptual developments. What had been solely the topic of philosophical speculation has now become open, at least in part, to laboratory investigation. A major theme in neurobiology to-day is representation or coding. What is the coding system with which the brain operates when it performs its remarkable feats?

The basic unit of function is the nerve impulse. Individual impulses are all alike and could not represent anything: it is only by their grouping in various ways that they can do so. Such grouping is central to coding information just as in morse code.[6] The grouping of nerve impulses is patterned both in time within each nerve fibre, the frequency code, and in space — that is among many fibres — the place code, which depends on which fibres are active. In studying the brain one is struck by the immense number of cells and nerve fibres which direct the action of the body. Even a relatively simple action like the movements of the chest in breathing is regulated by thousands of cells in several parts of the central nervous system. How much more complex must be the systems or programmes of activity for speaking, for feeling and ultimately for thinking? One complex high level process which is central to our understanding of the nature of human self-consciousness is language. Popper suggests that the self-conscious mind, in which the I is conscious of itself is only possible through language and through the development of imagination in that language.[7] Much of our understanding of the cerebral organisation of language and speech comes from clinical science. One hundred years ago the early advocates of duality of mind considered the two hemispheres of the brain to be functionally identical. The very idea that certain mental functions might be localised within specific brain areas was an anathema. Not surprisingly the early independent reports by Dax and Broca suggesting speech localisation in the left hemisphere provoked a harsh response. Such an asymmetry hypothesis was phrenological nonsense and not worthy of scientific attention. When Broca reported eight new cases supporting a localisation of expressive speech in the third frontal convolution he qualified his observations "I dare draw no conclusions and I await new facts".[10] Soon after, clinical studies revealed that the left superior temporal convolution and surrounding areas were critical for the understanding of speech.

Of course such knowledge arising from study of lesions should not hide from us the incredible complexity of the encoding and decoding involved in speech and language. Beginning with Penfield and his associates, stimulation of the cerebral cortex has provided new and important evidence on the organisation of language functions. One important finding from the recent work of Ojemann is that the language cortex is discretely organised. In almost half the sites studied, only single specific functions were affected by stimulation — for example in one bilingual subject naming in English and in Greek were separately affected.[11]

A third clinical dimension which sheds light on the mind-brain problem is the effect of transection of the corpus callosum for the amelioration of intractable epilepsy. These commissurotomy patients have been systematically investigated by Sperry and his associates[12] and one outstanding discovery is the uniqueness of the left hemisphere in conscious experience.[8] While the right hemisphere continues to perform at a very superior level, indeed better than the left hemisphere in pattern recognition, none of the goings on in this hemisphere give conscious experience to the person. Indeed the subject disclaims responsibility for the actions initiated within this hemisphere. Such evidence supports the view of the Nobel Laureate Sir John Eccles that activities in the right hemisphere in normal intact subjects only reach consciousness after transmission to the left hemisphere.[7]

The exclusive association of speech and consciousness with the left hemisphere raises the question: are there some special anatomical structures in this hemisphere that are not matched in the right? It has now been shown that about 80% of human brains possess anatomical asymmetries with special developments of the cerebral cortex in the regions of the speech area (Fig 5). There is hypertrophy of a part of the left superior temporal gyrus, the planum temporale. Similar asymmetries in this region have been reported in infants.[13] Why is this region of the inferior parietal lobule utilised for language?

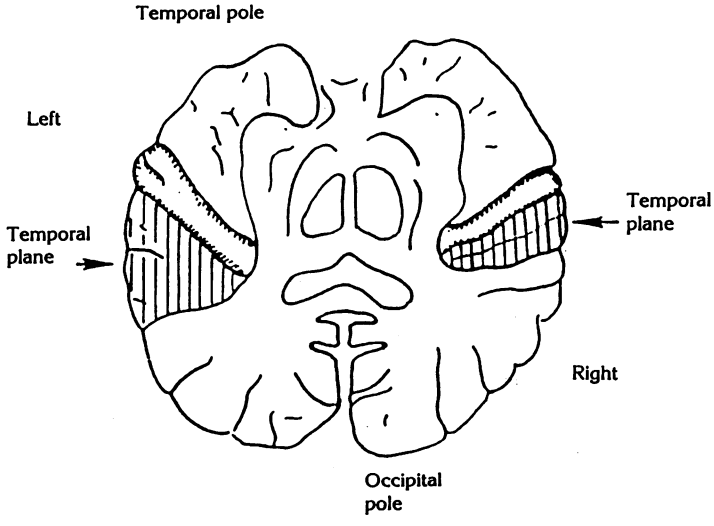

Fig 5. The upper surfaces of the temporal lobe has been exposed by a cut on each side in the plane of the Sylvian fissure. The temporal plane (vertical lines) is bordered anteriorly by the posterior border of Heschl's gyrus, posteriorly by the posterior border of the Sylvian fossa and laterally by the Sylvian fissure. Note the right-left differences in the temporal plane.

In primates this region (Broadmann areas 39, 40) has been shown to be the site where touch, visual and auditory information converge. Geschwind proposed that these area are unique in having developed to enhance the ability for cross-modal associations — a prerequisite for the acquisition of language,[14] and Teuber commented that language freed us to a large extent from the senses and gave access to concepts that combine information from different sensory modalities and is thus intersensory or supersensory.[15]

No doubt influenced by studies of clinical lesions, we have tended to focus our investigation of brain functions on specific anatomical loci. The great Russian neuropsychologist Alexander Luria cautioned on the dangers of a narrow localisationism, on the false premise that higher cognitive processes have a focal basis.[16] It seems most likely that higher cerebral functions emerge from high level neural networks which integrate and organise local brain regions. An understanding of such intermediary networks is probably critical to any further understanding of the relationship between cerebral activities and thinking, and new insights into these high level cerebral processes are beginning to emerge from modern brain imaging techniques.[17]

CONCLUSION

After this brief reflection on the self and its brain, Pinels' pioneering journey into reductionism as a physician and scientist may be less threatening — increased knowledge may not detract from human dignity. On the contrary, reductionism seeks an understanding of ourselves beyond the simple impressions of the senses. The properties of mind are determined in large part by the properties of highly organised neural networks of the brain — but not, I suggest in its entirety. Any theory of the self and its brain if it is to be effective in accounting for the vagaries of human behaviour, normal and abnormal, must also be able to account for the reality of the mind and its meanings.

A major aspiration of modern neuroscience is that further investigation of psychophysical relationships will provide a more precise description of the ways in which bodily states influence the mind and vice versa. At the very least we might hope to define the rules that determine the correlations between mental and physical events. The essence of our present position was eloquently summed up by Aristotle: "Soul and body, I suggest, react sympathetically upon each other: a change in the state of the soul produces a change in the shape of the body; and conversely a change in the shape of the body produces a change in the state of the soul".[7]

The title of this article was chosen in recognition of the valuable contribution to the topic by Sir Karl Popper and Sir John Eccles and reviewed in their book with the same title.

Figure 2 was reproduced by kind permission of the Hulton Picture Company London, and Figure 5 by Paul Eleck (Scientific Books) Ltd.

Figures 1, 3 and 4 were drawn by Mrs Yvonne Naylor.

REFERENCES

1. Hunter RA, MacAlpine I. Three hundred years of psychiatry, 1535–1860. London: Oxford University Press, 1963: 602.
2. Globus G, Maxwell G, Savodnik I. Consciousness and the brain: a scientific and philosophical enquiry. London: Plenun Press, 1976.

3. Ree J. Descartes. London: Allen Lane, 1974.
4. Barrett W. Death of the soul. Oxford: Oxford University Press, 1987.
5. Searle J. Minds, brains and science. London: British Broadcasting Corporation, 1984.
6. Young JZ. Philosophy and the brain. Oxford: Oxford University Press, 1988.
7. Popper KR, Eccles JC. The self and its brain. London: Routledge and Kegan Paul, 1977.
8. Sperry R. Consciousness, personal identity and the divided brain. *Neuropsychologia* 1984; **22**: 661-73.
9. Bunge M. The mind-body problem. A psychological approach. Oxford: Pergamon Press, 1980.
10. Harrington A. Nineteenth-century ideas on hemisphere differences and "duality of the mind". *Behavioural and Brain Sciences* 1985; **8**: 617-60.
11. Ojemann GA. Brain organisation for language from the perspective of electrical stimulation mapping. *Behavioural and Brain Sciences* 1983; **6**: 189-230.
12. Sperry RW. Mental unity following surgical disconnection of the cerebral hemispheres. The Harvey Lecture Series 62. New York: Academic Press, 1968.
13. Geschwind N, Levitsky W. Human brain: left-right asymmetries in temporal speech region. *Science* 1968; **161**: 186-7.
14. Geschwind N. Disconnection syndromes in animal and man. *Brain* 1965; **88**: 237-94.
15. Teuber HL. Lacunae and research approaches to them. In: Millikan CH, Darley FL (eds). Brain mechanisms underlying speech and language. New York: Grune and Stratton, 1965: 204-16.
16. Luria AR. Higher cortical function in man. London: Tavistock Publications, 1966.
17. Petersen SE, Fox PT, Posner MI, Mintum M, Raichle ME. Position emission tomographic studies of the cortical anatomy of single-word processing. *Nature* 1988; **331**: 585-9.